Effects of Training with an Increase in Training Bar Diameter on Strength and Functional Endurance Within Older Adults

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By

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Michael Thomas Markewich, candidate for the degree of Master of Science in Kinesiology & Health Studies, has presented a thesis titled, *Effects of Training with an Increase in Training Bar Diameter on Strength and Functional Endurance Within Older Adults*, in an oral examination held on July 6, 2020. The following committee members have found the thesis acceptable in form and content, and that the candidate demonstrated satisfactory knowledge of the subject material.

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Abstract

It is well established that there is an underlying process of muscular atrophy that occurs throughout the aging process. This issue of muscle atrophy more specifically known as sarcopenia, has been (and will continue to be) a great burden on both health care and quality of life. Current research has shown the importance of resistance training (RT) within all age groups, regardless of level of functionality or lifestyle. It was hypothesized that aging adults (≥50 years of age) who completed a 6-week RT program using a thick training bar attachment would increase upper limb muscle strength and endurance (primary outcome measure: handgrip strength; secondary outcome measures: handgrip endurance, upper body strength) to a greater extent than individuals who completed a program without the attachment. To the author’s knowledge there is no current research outlining any similar interventions involving aging adults and strength adaptations of the upper extremities of this nature.

Twenty-nine participants completed the study [experimental group: n = 15 (7 F, 8 M); control group: n = 14 (8 F, 6 M)]. No significant baseline differences between the groups were noted for sex ($p = .573$), age ($p = .685$), BMI ($p = .224$), or hand size ($p = .713$). When the data for both groups was combined, there were significant improvements over time for most strength and endurance outcomes [grip strength ($p = .018$), static grip endurance ($p = .010$), 1 RM lat pull down ($p < .001$), 1 RM biceps curl ($p < .001$), 1 RM triceps extension ($p < .001$)]. However, there were no significant differences between the groups post-intervention.

Future research is warranted, with careful consideration towards factors such as sleep schedule, macronutrient intake and supplementation use, which were not assessed
within the study. Although there were non-significant differences between the groups post-intervention, there were positive results across both training groups leading to the conclusion that positive physiological results can be attained within this age demographic while implementing effective training strategies, with or without the use of the training bar attachment.

*Keywords: Grip Strength, Aging Muscle, Older Adults, Resistance Training, Sarcopenia, Independence, Quality of Life, Fat Gripz*
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List of Abbreviations

1RM – 1-repetition maximum
ANOVA – Analysis of variance
BMI – Body Mass Index
CEP – Clinical Exercise Physiologist
CI – Confidence interval
CSEP – Canadian Society for Exercise Physiology
CVD – Cardiovascular disease
DB – Dumbbell
EWGSOP – European Working Group on Sarcopenia in Older People
FC – Farmer’s carry
FG – Fat Gripz
GAQ – Get Active Questionnaire
Kg – Kilogram
LP – Linear periodization
M – Meters
NSCA – National Strength and Conditioning Association
RCT – Randomized controlled trial
REB – Research Ethics Board
RT – Resistance training
SD – Standard deviation
SO – Sarcopenic obesity
I Introduction

Maintenance of muscular strength throughout the aging process is essential to increased functional mobility, as well as physical health (Hunter et al., 2004). All older adults are susceptible to continuous loss in muscle mass over time, which can significantly increase the risk of reduced functional mobility and the development of many health-related diseases (Cruz-Jentoft et al., 2018). It is well established within the health field that both muscle strength and quality decrease with advancing age, which highlights the importance of maintaining strength throughout the lifespan (Goodpaster et al., 2003, Cruz-Jentoft et al., 2018). This loss of muscle mass throughout the aging process is referred to as sarcopenia (i.e. muscle atrophy). Strength decreases by 1.5-5% annually in adults older than 40, and the resulting sarcopenic state can have a negative impact on quality of life (Cruz-Jentoft et al., 2018). It has been noted within the literature that strength training can elicit an increase in lean tissue mass (muscle hypertrophy), as well as muscular strength, which can directly combat this underlying issue of loss in muscle mass throughout the aging process, and could in turn prove to increase quality of life and independence over time (Hunter et al., 2004).

Strength training is important, not only for high performance athletes, but for older adults as well. Specifically, Hunter and colleagues (2004) note numerous benefits regarding strength training within an aging population, eliciting positive physiological adaptations such as an increase in muscle mass, strength and power; while also decreasing the difficulty in performing activities of daily living, and promoting participation of spontaneous physical activity. With this being said, it is essential to find optimal training techniques and modalities to further combat sarcopenia, in order to
sustain muscular strength, quality of life, and functional mobility within the aging
population of Canadian society.

2 Research Significance

Canada’s population is aging. According to the 2016 census, Statistics Canada
determined that two percent of Canada’s population were aged eighty-five and older,
equaling about seven hundred and fifty thousand individuals; it is estimated by Statistics
Canada that by the year of 2051, roughly six percent of Canada’s population will be aged
eighty-five or older, projected to equal about three million individuals across the nation
(Statistics Canada, 2017). With this projected increase in the aging population (i.e.
individuals currently 50 years of age or older), it is essential to adapt as a society to
account for the potential increased financial strain on health care resources attributable to
loss of independence within this age demographic.

Financial impacts of health care are important to consider on a national level. It is
essential to maintain the level of professional health care this country offers through its
health care system. There will be a high priority need for additional qualified individuals
who are able to assist these increasing medical needs, such as physicians and nurses,
which will potentially create additional increases in financial constraints on our economy
(Janssen et al., 2004). The financial constraints that this increase in the aging population
will potentially have on Canada and its health care system could prove to be significantly
detrimental. We must therefore implement research to identify intervention strategies to
help increase independence and functional mobility within the aging population, not only
to decrease the strain on health care, but to also increase quality of life and independence
within this age demographic, whilst maintaining muscular strength and quality at optimal rates.

Serving as comparison on a larger population base, within the United States it is estimated through public surveys that direct health care cost which are attributable to sarcopenia was 18.5 billion dollars in the year 2000 (Janssen et al., 2004). With this being said, “A 10% reduction in sarcopenia prevalence would result in savings of $1.1 billion per year in U.S. healthcare costs.” (Janssen et al., 2004, p. 3).

Various research studies across multiple disciplines have shown that with the implementation of resistance training (RT), increases in muscular strength and hypertrophy will occur (Fiatarone et al., 1994; Hunter et al., 2004). Muscular hypertrophy is the underlying increase in muscle fiber size and diameter, which also directly increases functional mobility and quality of life through a potential increase in independence. Therefore, in order to decrease the prevalence and severity of sarcopenia, it is essential to not only apply resistance training to various population groups, but to find the optimal techniques and interventions of exercise, within independent population groups, in order to assure maximal potential is being met. With new research emerging every year, physiologists are becoming more creative in ways to apply resistance training to various population groups, such as high performance athletes and bodybuilders. However, older adults are often overlooked when it comes to specialized resistance training interventions. The current research study aimed to fill the alarming gap within the current literature surrounding muscular strength and functionality (i.e. physical performance assessed through strength and endurance capacity) in older adults (≥50 years of age).
3 Literature Review

3.1 Aging Muscle

Aging muscle is susceptible to detrimental physiological adaptations, commonly cited as (but not limited to) sarcopenia and dynapenia. The combination of a loss of both muscle mass and muscle strength have been determined to be one of the leading causes of loss of independence and quality of life as one ages, which highlights the importance of physical training (Cruz-Jentoft et al., 2018). Inherently, these processes are detrimental due to factors that subsequently arise at a cellular level regarding satellite cells and recovery of muscle tissue from activity, which may have an overall effect on the metabolic pathways themselves (Alway et al., 2014).

3.1.1 Sarcopenia. Sarcopenia is commonly defined as a loss in muscle mass, which occurs throughout the aging process. This results in a significant loss of strength and independence within the aging population, and places potential financial strain on health care resources around the world (Cruz-Jentoft et al., 2018). This loss in muscular strength has a negative impact on independence and quality of life, which has also been noted as the leading characteristic attributable to sarcopenia by the European Working Group on Sarcopenia in Older People (EWGSOP) (Cruz-Jentoft et al., 2018). As noted within the literature, sarcopenia accelerates past the age of fifty, while “advanced sarcopenia leads to functional decline…which confers high risk for independence, disability, hospitalization and mortality” (Hunter et al., 2004, p. 2). It is also noted that progressive loss of muscle mass, as well as loss of strength (i.e. dynapenia), occurs throughout adult life, accelerating in middle age, which is then maintained into old age if no interventions are introduced (Wolfe, 2006; Cruz-Jentoft et al., 2018). As stated previously, annual reductions ranging from 1.5-5% in strength and 1-2% in muscle mass of the lower limbs
have been noted to take place after the age of 50 (Keller et al., 2013). Therefore, maintenance of muscular strength, endurance and quality throughout the aging process are beneficial regarding an individual’s independence and quality of life.

Although the true mechanisms attributable to sarcopenia are not well understood, there are likely a number of physiologic and environmental factors, which play an important role in the increase of this disease around the world. Physiological factors contributing to sarcopenia include (but are not limited to) the loss of α-motor neurons (Vandervoort, 2002), a decrease in physical activity levels (Szulc et al., 2004), reduced protein synthesis (Dickinson et al., 2013) and inadequate nutrition (Dreyer & Volpi, 2005, Candow, 2011). With all of these factors coming into play regarding the onset of sarcopenia, researching sound intervention strategies are of vital importance to minimize the loss of muscle mass in older adults by adapting the external environment in favor of the individuals experiencing this disease, with the goal of increasing, or at the very least maintaining, muscular strength and endurance at optimal rates throughout older age (Cruz-Jentoft et al., 2018).

Hunter and colleagues (2004) provide an explanation of the relationship between sarcopenia and loss of independence. Specifically, it is noted that sarcopenia does in fact present a major public health concern to society’s aging population, “as both the quality of life and the likelihood of age associated declines in health status are influenced.” (Hunter et al., 2004, p. 2). This decline in health has numerous effects on the individual both physiologically and psychologically, as debilitating diseases attributed to sarcopenia decrease the individual’s ability to participate in activities of daily living, while also diminishing quality of life (Cruz-Jentoft et al., 2018). Sarcopenia negatively impacts the
individual’s ability to independently participate in activities of daily living such as carrying groceries, gardening activities and climbing stairs (Short & Nair, 2001) and is a contributor to increases in fragility and likelihood of injury due to falling (Hunter et al., 2004).

With increasing research surrounding sarcopenia and the characteristics of this disease (i.e. loss of strength), there are now additional categories, which have been recommended by EWGSOP. These categories of sarcopania are listed as primary or secondary, as well as acute or chronic (Cruz-Jentoft et al., 2018). It is noted that within some individuals, sarcopenia is mainly attributable to the physiological process of aging; therefore, sarcopenia is considered to be primary when, “no other specific cause is evident” (Cruz-Jentoft et al., 2018, p. 8), and secondary when other factors may be evident (Cruz-Jentoft et al., 2018). For example, sarcopenia can occur as a result of a debilitating disease such as cancer or organ failure and therefore would be considered as secondary since the onset is not solely based on the physiological process of aging (Cruz-Jentoft et al., 2018). However, physical inactivity can also lead to the development of this disease, regardless of whether or not this inactivity is due to sedentary behavior or some type of physical limitation with regards to mobility (Mijnarends et al., 2016). Although there are clear differences between primary and secondary sarcopenia, they are undoubtedly related as one can and will affect the other. Recently, EWGSOP has listed two new subcategories of sarcopenia after the latest review of the literature, pertaining to acute and chronic sarcopenia. As this distinction between acute and chronic sarcopenia is aimed at increasing awareness of conducting periodic sarcopenia test administrations in a clinical setting, sarcopenia that has lasted less than 6 months is considered acute, and
cases that have persisted $\geq 6$ months are considered chronic (Cruz-Jentoft et al., 2018). However, it can be argued that with an appropriate RT regimen, acute cases of sarcopenia, which are not attributable to a secondary disease/sickness could be eliminated, which is why future research within this field is warranted.

This physiological process of degradation of muscle not only elicits the impaired ability to participate in activities of daily living, but in turn can also lead to a subsequent increase in fat mass (Marzetti et al. 2009). Sarcopenic obesity (SO) refers to the physiological condition of both reduced lean muscle mass accompanied by excess subcutaneous fat (Prado et al., 2012). This is problematic for many reasons. As an individual progresses through the aging process, it is evident that this is associated with physiological adaptations to the body’s imposed stressors (e.g., resistance training, aerobic training, etc.), both having significant impact on metabolic and cardiovascular function of the human body, specifically within aging males (Jackson et al., 2012). Insufficient amounts of physical activity as well as a poor diet have both been linked to the degradation of physiological health throughout the lifespan. Therefore, it is vital to implement and adapt current exercise prescriptions for older males and females specifically to help minimize the loss of muscle strength, muscle quality and muscle quantity (Cruz-Jentoft et al., 2018).

3.1.2 Satellite Cell Function. Satellite cells are a grouping of adult muscle stem cells, which are most commonly referred to as quiescent (Alway et al., 2014). Located between the sarcolemma and the basement membrane of the muscle fibre, their main importance revolves around their critical role of aiding in muscle growth and repair, including the human body’s process of muscular adaptation with regards to physical stressors such as
exercise and aging (Alway et al., 2014). Although satellite cells are usually inactive, they become active once they are exposed to an external stressor such as physical activity (Alway et al., 2014). This is specifically important within aging muscle, as the main fitness goal for this aging population is to increase lean tissue mass with hopes of maintaining muscular strength, functionality and levels of independence regarding quality of life and participation in activities of daily living.

However, satellite cells are not only of importance regarding muscle repair following injury and external stressors, but also in regulating key aspects of muscular hypertrophy (Fry et al., 2014). This creates the possibility that, “a diminished function in satellite cells plays an important role in mediating the long-term muscle reductions with sarcopenia” (Alway et al., 2014 p. 3). There is also scientific evidence supporting the notion that the subsequent reduction in satellite cell number with aging can also directly contribute to muscle fibre atrophy (Brack et al., 2005). Since satellite cell function is reduced in aging muscles (Alway et al. 2014), it is important to take this into consideration regarding intervention strategies, specifically regarding physical activity within this age demographic. The maintenance of muscular strength and endurance could therefore both be seen as positive adaptations towards an exercise regimen for this reason, rather than solely due to increases in muscular hypertrophy.

3.2 Resistance Training within Aging Populations

With research showing the negative health effects of sarcopenia, it is vital to reverse or blunt this outcome on human health as the aging process occurs, in order to increase independence and quality of life. It has been noted that exercise interventions, applied to those who are experiencing sarcopenia, can successfully improve functionality
A lack of physical activity has been shown to illicit an increased risk of cardiovascular disease (CVD), which is in part due to the physiological effects of sarcopenia accompanied by an increase in fat mass over the aging process (WHO, 2018; Marzetti et al. 2009; Prado et al., 2012).

Meaningful and effective intervention strategies are of paramount importance in combating sarcopenia, on both a national and global scale. Even though there have been a number of interventions proposed for older adults to reduce the decline of muscle quality and quantity (Cruz-Jentoft et al., 2018), it is essential to explore modalities which are cost-effective for both the health care system, and the individuals who are being affected by this disease.

It has been advised that the average individual should partake in at least 150 minutes of physical activity per week (Heart and Stroke Foundation, 2017). However, the increase of physical activity can prove to be quite daunting to the average individual, with regards to time commitment and lack of knowledge and experience. Lack of time has been cited by Canadians as one of the leading factors regarding the absence of regular physical activity (Sallis, Hovell & Hofstetter, 1992). These are just a few of the reasons why physical activity proves to be intimidating for many individuals, which may in fact drive them away from partaking in any physical activity at all, potentially leading to negative health complications such as sarcopenia (Mijnarends et al., 2016). Even though it is now well established that an adequate level of physical activity is needed in order to obtain optimal health, there is sparse research on specific modalities of exercise to counteract the effects of sarcopenia within an older population. This highlights the need
for innovative research focused around optimal strength adaptations through specific training modalities with the least amount of time required.

It is indeed an intriguing concept to theorize specific training modalities of which could potentially decrease certain risk factors related to sarcopenia. With time commitment and motivation acting as barriers towards physical activity, it is essential to discover efficient, non-invasive, and cost-effective methodologies that can be prescribed to both people suffering from sarcopenia, as well as the general public, in order to blunt or even help eliminate sarcopenic traits, and their corresponding health concerns which can coincide with life-threatening health conditions, such as an increase in fat mass, stroke and CVD (WHO, 2018; Marzetti et al. 2009; Prado et al., 2012).

Improving functionality (i.e. physical performance) through application and implementation of exercise interventions could directly translate to an increase in independence and quality of life. RT can elicit positive outcomes on human physiology, such as the induction of muscular hypertrophy and increase in muscular strength, in response to sarcopenia (Hunter et al., 2004). It is important to not only apply appropriate exercise prescription within the aging population, but to implement the most effective training interventions in order to attain the greatest benefit in muscular health through the subsequent increase, or at the very least maintenance, of strength (Cruz-Jentoft et al., 2018). This application will therefore potentially increase quality of life and independence over the lifespan of the individual.

RT has been shown to promote muscular hypertrophy and strength within all populations, and is important to incorporate into an individual’s lifestyle to ensure healthy balance of the musculature, while also promoting increases of independence as
individuals go through the aging process. Therefore, “A primary focus of resistance training prescription among the elderly is the induction of muscle growth (i.e. hypertrophy) in an effort to counteract sarcopenia” (Hunter et al., 2004, p.3). It has been shown by numerous studies that older muscles quickly adapt to RT, showing significant evidence of muscular hypertrophy and strength (Hunter et al., 2004). More specifically, “Myofibre hypertrophy following a typical 2-3 days per week training program can be substantial, ranging from 10% to 62% after 9-52 weeks of training.” (Hunter et al., 2004, p.6). Although these ranges appear quite large, it is important to note that achieving an adequate level of strength maintenance should be viewed as a positive outcome of a training regimen within this age demographic (≥50 years of age) as muscular hypertrophy is more difficult to attain due to a number of confounding factors involving the aging process. With this in mind, increasing and/or maintaining muscular strength is of equal value regarding RT.

RT has a positive effect on aging muscle, which has been supported by the literature. However, with the most practical issue being motivation, it is vital to identify and justify the least amount of exercise needed to achieve the desired results (e.g., counteracting the debilitating effects of sarcopenia) (Wolfe, 2006).

3.3 Grip strength

Grip strength is a commonly used indicator of overall body strength by both fitness professionals and physicians. Within the aging population, it has been documented throughout the literature that grip strength can serve as a good indicator of an aging individual’s overall strength and level of independence. A systematic review summarizing existing literature regarding the value of grip strength as a predictor of
clinical outcomes in older adults was published in 2008 (Bohannon, 2008). The purpose of this systematic review was to compile the existing literature, and compare findings based on the importance of grip strength as an assessment tool. Key findings throughout this systematic review include the conclusion that, “Low grip strength was shown consistently to be associated with a greater likelihood of premature mortality, the development of disability, and an increased risk of complications or prolonged length of stay after hospitalization or surgery” (Bohannon, 2008, p.1). There have been studies linking the importance of grip strength within middle aged and older adults to not only loss of physical function through disability, but also mortality. Therefore, weaker grip strength is often correlated with significant decreases in both health and physical function in older adults.

Although the relationship between grip strength and other physiological factors has been made, it is important for future research to examine how to effectively increase grip strength within the elderly population, in order to increase functional mobility of the upper extremities to assist with activities of daily living and independence. With evidence showing the relationship between grip strength and ambulatory capability (Beseler et al., 2014), it is essential to apply further research to the issue of diminished total body strength, due to effects of sarcopenia within the upper limbs as well as this effect on total body strength. It is possible to potentially stop or delay this process of sarcopenia within the aging population, thus having a positive impact on ambulatory capabilities as well as increases in functional mobility and strength through proper exercise intervention and RT modalities (Hurley et al., 2000). Investigating factors associated with decreased grip
strength within the aging population is vital and would supply more health related information on older adults to physicians around the world (Lenardt et al., 2016).

As stated previously, muscular strength is now noted by EWGSOP as the leading factor in relation to sarcopenia (Cruz-Jentoft et al., 2018). Serving as the gold standard, grip strength has been listed as the most appropriate method in testing strength in older adults at risk of sarcopenia in both clinical and research settings (Cruz-Jentoft et al., 2018). With this being said, it is crucial to investigate future research strategies to implement and carry out examinations in order to discover the most appropriate and efficient ways to increase and/or maintain strength, especially within the upper limbs with regards to grip strength, as there is currently a huge gap within the literature regarding specialized resistance training within this age demographic. For the current study, it was hypothesized that by increasing the size in diameter of the training bar used, older adults would attain a significant increase in muscular strength and endurance by increasing physiological adaptations through a specialized exercise intervention.

3.4 Fat Gripz

The Fat Gripz (FG) bar attachment is a training bar attachment which increases the diameter of the bar, thereby theoretically increasing the amount of grip strength required (Fat Gripz, n.d.). This also potentially increases the activation of the muscles of the arms through isometric contraction, due to the installment of an overall thicker training bar (Fat Gripz, n.d.). Currently, there are three models available to the public for purchase ranging in size (measured by total diameter) from 1.75 inches/4.5cm (i.e. Fat Gripz One), 2.25 inches/5.7cm (i.e. Fat Gripz Original) and 2.75 inches/7cm (i.e. Fat
Gripz Extreme) in comparison to a traditional Olympic barbell, which has a diameter of 1.1 inches/2.8 cm (Fat Gripz, n.d.).

Heyboer and colleagues state within their research study that RT is one of the most important aspects for athletic improvement in every level of athlete (Heyboer, Leathley & VanZytveld, 2014). The main topic of their research provides the question of whether or not an increased bar diameter (using FG) has a greater effect on muscular strength, through testing maximal grip strength and 1-Repetition Maximum (RM) lat pull down, following an exercise program. With the sample size being generally small (n=14), all male, and all between the ages of eighteen to twenty-two years of age, the generalizability of the findings is severely limited. However, they concluded that the group using the greater bar diameter (using FG) showed trends towards an increase in lat pull down 1-RM. However, there are often limitations within certain populations regarding health and safety risks, so it is important to research optimal training techniques not only for athletic populations, but for clinical populations as well.

A second study recruited 13 healthy female participants from a university setting (Rogers, 2016). The purpose of this study was to determine whether or not an increase in bar diameter while training (using FG) would have a significant effect on 5-RM deadlift values and muscle activation (Rogers, 2016). There was no significant difference in the increase of strength shown by the FG group compared to a control group (i.e. intervention with no use of FG), and the author speculated that this could be due to the participants having smaller hands than males, and thus not being able to fully grasp around the FG attachment to attain full benefits from the imposed resistance training program (Rogers, 2016). This study by Rogers is valuable, specifically regarding the fact that some of the
participant’s hands were too small to use the FG attachment, which is an important note to make moving forward throughout the literature as there are currently no recommended anthropometric hand dimensions which have been put in place.

There is a major gap within the research base focusing on the implementation of the FG training bar attachment. Specifically, there is a lack of published research on the use of an increased training bar diameter as an exercise intervention within the population of older adults. An increased bar diameter may not only have a positive training outcome for competitive athletic populations or young adults, but for older adults and clinical populations as well in terms of increasing functional mobility and strength, theoretically leading to an increase in independence and quality of life over time.
4 Methods

The purpose of this research study was to determine whether a RT program with an increase in training bar diameter by using the FG original (i.e. 2.25 inches/5.7cm diameter) attachment, compared with the same RT program without an increase in bar diameter, would significantly increase handgrip strength, handgrip endurance, and upper body strength within an aging population of healthy males and females (≥50 years of age). The main research questions addressed by the study are the following:

1. In a sample of older adults, does a RT program that incorporates the FG attachment (intervention) lead to greater improvements in handgrip strength (dynamometer) compared to the same RT program that does not incorporate the attachment (control)?

2. In a sample of older adults, does a RT program that incorporates the FG attachment (intervention) lead to greater improvements in handgrip endurance (double dumbbell (DB) hold, farmer’s carry (FC)) compared to the same RT program that does not incorporate the attachment (control)?

3. In a sample of older adults, does a RT program that incorporates the FG attachment (intervention) lead to greater improvements in upper body strength (biceps curl, triceps extension and lat pull down 1RM) compared to the same RT program that does not incorporate the attachment (control)?

4.1 Participants

An a priori power analysis (G*Power v. 3.1.9.2) indicated that 34 participants were required (17 per group) based on: an alpha level of 0.05, a power level of .80, and a moderate effect size (Cohen's f = 0.25) for a 2 (group) x 2 (time) mixed model analysis of
variance (ANOVA) design (Faul, Erdfelder, Lang, & Buchner, 2007). Recruitment was completed though convenience sampling from the University of Regina, local fitness centres (e.g. YMCA of Regina) as well as the University of Regina e-mail server list. All participants were required to fill out a Get Active Questionnaire (GAQ), which assesses an individual’s readiness for participation in resistance training and/or physical activity (including current/baseline level of self-reported physical activity). This questionnaire includes questions related to heart conditions, angina at rest or during physical exercise, balance, and bone or joint problems that may prove to be a contraindication towards exercise performance and potential adaptations. Participants were also required to fill out an informed consent form, stating that they were willing to participate in the study and aware of any general risks surrounding resistance training and physical activity. Inclusion criteria for the study included: age $\geq$ 50 years; no contraindications to exercise (as assessed by the GAQ), training status (no supervised training sessions 3 months prior to enrolment) and the ability to commute to the University of Regina for all scheduled training sessions. Exclusion criteria included: any debilitating disease affecting either neuromuscular control or the musculoskeletal system (such as Multiple Sclerosis, Amyotrophic Lateral Sclerosis, Parkinson’s disease and Alzheimer’s disease); history of fragility fractures and/or clinically diagnosed osteoporosis; diseases that are known to affect muscle biology; severe osteoarthritis; or if they planned to travel during the study period for greater than 2 weeks duration at a time.

It has been stated within previous research on Fat Gripz (FG) that some individuals’ hand anthropometrics have been too small to effectively use the FG attachment tool within a RT regimen (Rogers, 2016). As research is limited on FG, there is no proposed
anthropometric hand dimensions required to effectively use FG within a RT program. For this reason, hand size measured from the styloid process of the radius to the tip of the third metacarpal was assessed (average of right and left) to account for any potential differences between groups. Prior to undertaking the study, approval from the University of Regina Research Ethics Board (REB) was granted before any participants were able to continue with pre-screening as well as initial testing during the familiarization phase.

4.2 Research Design

The current study implemented a quantitative, randomized controlled trial (RCT) with a repeated measures design. A convenience sample of older adults was randomized on a 1:1 basis regarding allocation to one of two groups: Group 1 (control: no Fat Gripz attachment) or Group 2 (intervention: Fat Gripz attachment). Due to the nature of the study implementing a visual external bar attachment, while also implementing supervised training sessions, it was challenging to achieve blinding for either the participants or the researcher during training sessions. To limit any potential bias, a third party research assistant tested all baseline and post-intervention dependent variables to ensure accurate, unbiased testing results.

Participant safety is of utmost importance. This was ensured through 3 sessions of familiarization, immediately followed by the 6-week intervention with all training sessions remaining supervised by a Clinical Exercise Physiologist (CEP). The dependent variables measured at baseline and post-intervention (all measurements were completed without the FG attachment for both the experimental and control group) by a research assistant include: (1) handgrip strength (dynamometer), (2) handgrip endurance (DB hold for maximum time at 60% body weight (30% per hand), FC for maximum distance at
40% body weight (20% per hand)) and (3) upper body strength (biceps curl, triceps extension and lat pull down 1RM values).

4.3 Resistance Training Program Design

All familiarization and training sessions within the study took place at the University of Regina, in the faculty of Kinesiology and Health Studies (Aging Muscle and Bone Health Laboratory and Exercise Physiology Laboratory) over the span of roughly 8 weeks (2 weeks familiarization, 6 weeks RT protocol). The programming of any RT regimen requires appropriate rationale in accordance to the programming goals. These variables include but are not limited to training period (i.e. how long?), frequency (i.e. how often?) and intensity (i.e. how heavy?) of training as well as total volume (i.e. how many sets and repetitions?). Achieving an appropriate dose-response relationship between the individual and the RT program is essential to success through achieving further physiological adaptations such as increased muscle strength (Borde et al., 2015).

There was a preliminary familiarization period at the beginning of the study consisting of 3 sessions (requiring a minimum of 2 days between sessions). Within the first session of familiarization, participants were required to complete all forms including the GAQ, informed consent and intake form. Measurements of height (cm), mass (kg), and body mass index (BMI: kg/m²) were also taken within the first familiarization session. All inclusion and exclusion criteria were reviewed intensively to assure that the participant was suitable for the study prior to engagement. Once the participant was appropriately screened and invited to participate in the study, they were then randomized (on a 1:1 basis) to either the experimental or control group (without their knowledge) and the second familiarization session was scheduled.
At the second session of familiarization, the participant underwent baseline testing for the dependent variables (see 4.4). The third session of familiarization was the official introduction to the RT program which participants participated in for the duration of 6-weeks, with a total of 12 training sessions (i.e., two training sessions per week, with a minimum of 48 hours rest in between training sessions). This third session aimed at covering explanation and demonstration of proper form for each exercise, as well as explanation surrounding the RT program. The RT program consisted of various exercises surrounding the programming goals of increasing handgrip strength, handgrip endurance and upper body strength. At this time, explanation of concepts surrounding effective breathing technique and rest times were also addressed by the CEP to ensure that the participant understood the RT program in its entirety before commencement of the study.

Exercise selection was not adjusted throughout the 6-week RT program; however, variables of intensity did follow a linear periodization (LP) model (i.e. increasing intensity, respectively). The LP model was implemented throughout the 6-week training phase based on relative participant progression. LP has been shown throughout the literature to be one of the leading programming methods regarding increases in strength, and is also the most appropriate method of programming to be implemented within the proposed age demographic due to the gradual increase in intensity (Prestes et al., 2009). Specific program design and exercise selection included the following (in order): (1) 5 minute warm-up period (dynamic stretching session led by the CEP), (2) FC with DBs for a distance of 20 metres, (3) single arm DB row, (4) cable resisted lat pull down (hands positioned shoulder width apart, pronated grip), (5) cable resisted bilateral biceps curl (hands in supinated position) (6) cable resisted triceps extension (hands in neutral grip
position), (7) 5 minute cool-down session (various total body static stretching). As stated previously, exercise selection was not adjusted; however, variables of intensity (i.e. %1RM) gradually increased based on the participant’s level of strength increase over the 6-week time span of the intervention. This was achieved by initially setting each exercise (except FC – see below) to 60% of the individual’s given baseline 1RM, with total volume for each exercise set at 3 sets of 6-8 repetitions. Once the participant was able to achieve the full volume of 24 repetitions (i.e. 3 full sets of 8 repetitions) for back-to-back training sessions, weight was increased by 5-10lb increments as tolerated to achieve linear periodization over the span of the 6-week RT intervention.

During phase 1 of the RT program (weeks 1-3) FC was carried out at a volume of 3 sets of 20m walk, while eliciting a self-reported rating of perceived exertion (RPE) of 7-8. During phase 2 (weeks 3-6), the volume of 3 sets of 20m was not changed; however, the participant was then instructed to perform the FC with an increase of 5-10lb per hand as tolerated.

4.4 Dependent Variables

4.4.1 Handgrip Strength. The primary dependent variable for this study was handgrip strength. As stated in the Literature Review, handgrip strength is an extremely important measure of strength not only for task specific activities (e.g., carrying groceries, opening medication containers, using ambulatory assistance devices such as walkers and canes, etc.) but is also commonly used by both fitness professionals and physicians as a measure that is related to overall body strength. Maximal handgrip (isometric) strength was assessed by a CEP according to the testing protocol prescribed by the Canadian Society for Exercise Physiology (CSEP). This involved two measurements in total kilograms
taken from each hand (i.e., 4 trials in total), where the two maximal scores (maximum from each hand) were then added together to create a total measure of handgrip strength. The device that was used to quantify this measurement was a Jamar Handgrip Dynamometer, and scores were measured to the nearest 0.1 Kg, respectively.

**4.4.2 Handgrip Endurance.** Handgrip endurance was assessed by DB hold and FC. The DB hold involved the participant holding a DB in each hand at a weight of 60% body weight (i.e. 30%/hand, respectively) for as long as possible, with no FG attachment. The FC was a similar assessment regarding equipment and procedure (i.e., DBs with no FG attachment), while mimicking an activity of daily living (i.e. carrying groceries). This assessment involved the participant completing the FC as far as possible until the weight was dropped (distance measured in meters), while holding a total of 40% body weight (i.e. 20% in each hand, respectively).

**4.4.3 Upper Body Strength.** Upper body strength was assessed with a 1RM test for the cable-resisted lat pull down, biceps curl, and triceps extension (upper body strength) without the use of the FG attachment. All three exercises followed the same testing protocol, which was comprised of the following: (1) standard dynamic warm-up lasting 5 minutes, (2) 1 set of 10 repetitions using a weight determined by each participant to be comfortable and relatively easy, followed by 1 set of 5 repetitions using an increased weight (i.e. of roughly 20%), (3) weight was then progressively increased (by 2.5-10lb, as deemed appropriate by the CEP) for each subsequent 1RM attempt with a 5-minute rest interval in between attempts until 1RM was achieved.
4.5 Data Analysis

Within the proposed study, a 2 X 2 (Group: intervention - Fat Gripz™ vs. control, Time: baseline vs. post-intervention) mixed model analysis of variance (ANOVA) was used to assess for significant changes in each dependent variable between the two groups over time. An α of 0.05 was used to indicate statistically significant differences, and effect sizes were reported as partial eta². Both categorical and continuous baseline demographic variables were also assessed using both Chi-Square (e.g. participant sex) and independent T test analysis (e.g. hand size, age, body mass index and activity level measured in minutes per week) in order to determine potential significant demographic differences between the two groups.
5 Results

5.1 Participants

A total sample size of 29 participants (experimental group: n = 15; control group: n = 14) completed the study. Baseline demographic variables are reported in Table 1. No significant differences between the groups were noted for sex ($p = .573$), age ($p = .685$), BMI ($p = .224$), and hand size ($p = .713$). However, the experimental group reported performing significantly more leisure time exercise per week than the control group ($p = .009$).
Table 1

*Baseline demographic variables for the experimental group (n = 15) and control group (n = 14)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>7 F, 8 M</td>
<td>8 F, 6 M</td>
<td>$\chi^2 (1, 29) = .318, p = 0.573$</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>58.3 (5.1)</td>
<td>59.1 (4.5)</td>
<td>$t (27) = - .410, p = .685$</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>29.7 (5.9)</td>
<td>27.3 (4.4)</td>
<td>$t (27) = 1.245, p = .224$</td>
</tr>
<tr>
<td>Hand size (cm)</td>
<td>18.3 (1.3)</td>
<td>18.1 (1.5)</td>
<td>$t (27) = .372, p = .713$</td>
</tr>
<tr>
<td>Activity (min/wk)</td>
<td>208.7 (106.5)</td>
<td>101.8 (93.5)</td>
<td>$t (27) = 2.837, p = .009$</td>
</tr>
</tbody>
</table>

*BMI: body mass index; Activity: self-reported leisure time exercise per week.*

*Age, BMI, hand size, and activity reported as mean (SD).*
5.2 Dependent Variables

Baseline and post-intervention group averages for each of the dependent variables are reported in Table 2. These variables include: grip strength, static grip endurance, dynamic grip endurance, and 1RM upper body strength tests. All dependent variable data were assessed using 2x2 mixed model ANOVA statistical analyses to assess the main effects for time and group, and the time x group interaction effects.
Table 2

Baseline and post-intervention averages of each dependent variable for the experimental group (n = 15) and control group (n = 14)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
<th></th>
<th>Control Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Post-Intervention</td>
<td>Baseline</td>
<td>Post-Intervention</td>
</tr>
<tr>
<td>Grip Strength (kg)</td>
<td>73.8 (28.9)</td>
<td>76.3 (27.0)</td>
<td>65.1 (24.4)</td>
<td>70.9 (24.0)</td>
</tr>
<tr>
<td>Static grip endurance (s)</td>
<td>87.5 (42.7)</td>
<td>95.5 (39.8)</td>
<td>75.2 (39.1)</td>
<td>91.5 (49.8)</td>
</tr>
<tr>
<td>Dynamic grip endurance (m)</td>
<td>124.7 (92.5)</td>
<td>153.7 (93.8)</td>
<td>113.8 (75.7)</td>
<td>125.7 (84.7)</td>
</tr>
<tr>
<td>1 RM LPD (lb)</td>
<td>131.0 (43.0)</td>
<td>145.3 (45.0)</td>
<td>120.7 (39.5)</td>
<td>133.0 (41.9)</td>
</tr>
<tr>
<td>1 RM BC (lb)</td>
<td>77.7 (41.8)</td>
<td>97.0 (42.7)</td>
<td>75.2 (40.7)</td>
<td>91.6 (42.4)</td>
</tr>
<tr>
<td>1 RM TE (lb)</td>
<td>74.5 (30.5)</td>
<td>84.7 (32.2)</td>
<td>64.8 (26.0)</td>
<td>77.1 (29.3)</td>
</tr>
</tbody>
</table>

1 RM LPD: 1 repetition maximum for lat pull down; 1 RM BC: 1 repetition maximum for biceps curl; 1 RM TE: 1 repetition maximum for triceps extension.
All variables reported as mean (SD).
5.2.1 Grip Strength. When the data for both groups were combined, it was determined that there was a significant main effect for time \( F(1,27) = 6.386, p = .018, \eta^2 = 1.91 \), with grip strength being higher post-intervention compared to baseline; conversely, there was a non-significant main effect for group \( F(1,27) = .537, p = .470, \eta^2 = .02 \) and a non-significant time x group interaction effect \( F(1,27) = 1.059, p = .312, \eta^2 = .038 \) (see Figure 1).

![Group Mean Total Grip Strength (Kg) at Baseline and Post-Intervention](image)

**Figure 1**

*Visual representation of the mean value (Error bars: 95% CI) for both experimental and control groups regarding total grip strength (Kg) at baseline and post-intervention*
5.2.2 Static Grip Endurance. When the data for both groups were combined, it was determined that there was a significant main effect for time \[ F(1,27) = 7.068, p = .010, \eta^2 = .220 \], with grip endurance being higher post-intervention compared to baseline; conversely, there was a non-significant main effect for group \[ F(1,27) = .279, p = .602, \eta^2 = .01 \] and a non-significant time x group interaction effect \[ F(1,27) = .886, p = .355, \eta^2 = .032 \].

![Group Mean Static Grip Endurance (s) at Baseline and Post-Intervention](image)

**Figure 2**

*Visual representation of the mean value (Error bars: 95% CI) for both experimental and control groups regarding static grip endurance (s) at baseline and post-intervention*
5.2.3 Dynamic Grip Endurance. There were non-significant main effects for time \([F(1,27) = 4.088, p = .053, \eta^2 = .132]\) and group \([F(1,27) = .400, p = .532, \eta^2 = .015]\), and a non-significant time x group interaction effect \([F(1,27) = .711, p = .406, \eta^2 = .026]\) (see Figure 3).

![Group Mean Dynamic Grip Endurance (m) at Baseline and Post-Intervention](figure3)

**Figure 3**

*Visual representation of the mean value (Error bars: 95% CI) for both experimental and control groups regarding dynamic grip endurance (total distance walked, m) at baseline and post-intervention*
5.2.4 Upper Body Strength: 1RM Lat Pull Down. When the data for both groups were combined, it was determined that there was a significant main effect for time \([F (1,27) = 66.97, p < .001, \eta^2 = .713]\), with 1RM lat pull down being higher post-intervention compared to baseline; conversely, there was a non-significant main effect for group \([F (1,27) = .518, p = .478, \eta^2 = .019]\) and a non-significant time x group interaction effect \([F (1,27) = .382, p = .542, \eta^2 = .014]\) (see Figure 4).

![Group Mean 1RM Lat Pull Down (lb.) at Baseline and Post-Intervention](image)

**Figure 4**

*Visual representation of the mean value (Error bars: 95% CI) for both experimental and control groups regarding 1RM-testing value for the lat pull down (total pounds lifted, lb.) at baseline and post-intervention*
5.2.5 Upper Body Strength: 1RM Biceps Curl. When the data for both groups were combined, it was determined that there was a significant main effect for time \([F(1,27) = 111.02, p < .001, \eta^2 = .804]\), with 1RM biceps curl being higher post-intervention compared to baseline; conversely, there was a non-significant main effect for group \([F(1,27) = .065, p = .801, \eta^2 = .002]\) and a non-significant time x group interaction effect \([F(1,27) = .732, p = .400, \eta^2 = .026]\) (see Figure 5).

![Group Mean 1RM Biceps Curl (lb.) at Baseline and Post-Intervention](image)

**Figure 5**

*Visual representation of the mean value (Error bars: 95% CI) for both experimental and control groups regarding 1RM-testing value for the biceps curl (total pounds lifted, lb.) at baseline and post-intervention*
5.2.6 Upper Body Strength: 1RM Triceps Extension. When the data for both groups were combined, it was determined that there was a significant main effect for time \[ F (1,27) = 48.252, \ p < .001, \ \text{eta}^2 = .641 \], with 1RM triceps extension being higher post-intervention compared to baseline; conversely, there was a non-significant main effect for group \[ F (1,27) = .622, \ p = .437, \ \text{eta}^2 = .023 \] and a non-significant time x group interaction effect \[ F (1,27) = .443, \ p = .511, \ \text{eta}^2 = .016 \] (see Figure 6).

![Group Mean 1RM Triceps Extension (lb.) at Baseline and Post-Intervention](image)

**Figure 6**

*Visual representation of the mean value (Error bars: 95% CI) for both experimental and control groups regarding 1RM-testing value for the triceps extension (total pounds lifted, lb.) at baseline and post-intervention*
5.3 Initial Training Load Discrepancies

Although the RT program was initially designed to implement training loads based on the participant’s individual baseline testing values (e.g., starting point set at 60% baseline 1RM value for all cable resisted exercises during the third familiarization session), there were discrepancies between the experimental and control groups regarding the starting loads used at the first training session. This was due to the increase in training bar diameter initially making it more difficult for some of the participants in the experimental group to complete the required repetition ranges with the appropriate weights, which was determined in the third familiarization session prior to the introduction of the FG bar attachment for experimental group participants. Specifically: 1) ten participants in the experimental group (n=15) reduced the starting load in the FC by an average of 28% of their calculated starting load, 2) four participants in the experimental group reduced the starting weight in the single-arm dumbbell row by an average of 21% of their calculated starting load, 3) and seven participants in the experimental group reduced the starting weight in the biceps curl by an average of 13% of their calculated starting load.
6 Discussion

The primary purpose of this RCT was to determine the effect of an increase in training bar diameter using the FG training bar attachment during a 6-week supervised RT program within an aging demographic. To the author’s knowledge, this is the first study examining the direct impact of an increase in training bar diameter within older adults, specifically addressing functional measures of grip strength (dynamometer, Kg), grip endurance (static, total time in seconds; dynamic, total distance in meters), and upper body strength (1RM, total weight in pounds). It is well documented through previous literature that with the increase in strength in these (and similar) parameters, potential increases in functional measures of one’s ability to carry out tasks of every day life (e.g. carrying groceries) can be positively affected (Beseler et al., 2014; Bohannon, 2008; Hurley et al., 2000). However, previous studies that have examined the effect of an increase in training bar diameter using the same training bar attachment are limited (Heyboer, Leathley & VanZytveld, 2014; Rogers, 2016). Additionally, these previous studies included athletes and young adult participant samples, and do not address the increased need for strength and endurance within older individuals who are at an increased risk of both sarcopenia and dynapenia, especially after the fifth decade of life (Cruz-Jentoft et al., 2018). While resistance training within the aging demographic has previously shown positive results across many testing parameters and intervention strategies (Fiatarone et al., 1994; Hunter et al., 2004), the effect of a specific training intervention using an increase in training bar diameter within this age demographic regarding functional measures of both strength and endurance has not previously been investigated.
6.1 Primary Research Question

6.1.2 Grip Strength. Total grip strength was measured using a Jamar Handgrip Dynamometer adhering to CSEP testing guidelines (i.e. sum of highest testing value of each hand combined for total score). Although there was a significant increase over time for both experimental and control groups for total grip strength, there was a non-significant difference between the groups. Thus, the hypothesis that an increase in training bar diameter would have a significant effect on total grip strength when compared to a control group was not supported.

6.2 Secondary Research Questions

6.2.1 Grip Endurance. Grip endurance was measured in two separate conditions utilizing both static and dynamic testing guidelines. The static condition required participants to hold 30% of their body weight/hand (dumbbell) for maximum time (seconds), while the dynamic condition required maximum walking distance (20 meter walking track) until volitional fatigue (maximum distance). While there was a significant increase over time for the experimental and control groups for the static condition, there was a non-significant change over time for the dynamic condition. With this being said, it is important to address the effect size reported as partial eta squared within the results section (see 5.2.3). Partial eta squared effect sizes range from small to moderate to large (0.009, 0.05 and 0.13, respectively), which is in part a reflection of the variance within a dependent variable (e.g. total distance, m) with consideration towards the presence/absence of the independent variable (i.e. Fat Gripz attachment) once statistical analysis has been completed (Richardson, J. T., 2011). For dynamic grip endurance, although there was a non-significant main effect for time ($p = .053$), there was a large effect size ($\eta^2 = .132$). This alludes to the fact that reduced study power, due to a low participant completion rate (i.e. withdrawal), may have led to a type II error for dynamic grip endurance.
Additionally, there were non-significant differences between the groups for both conditions. Thus, the hypothesis that an increase in training bar diameter would have a significant effect on static and dynamic grip endurance outcomes when compared to a control group was not supported. One additional explanation for difference in the results for the static and dynamic outcomes is that the training program emphasized upper body training, specifically grip strength, rather than lower body training (excluding the FC as a total body exercise). As the dynamic condition involves the participant engaging in an ambulatory activity, this exercise would be considered to include total body effort, where the participant may be subject to less physical adaptations due to the RT program design incorporating four out of five exercises exclusive to upper body training. Although participants completed the FC within each training session, these three sets of twenty meters could have potentially been insufficient to have any specific positive adaptations in terms of muscle physiology of the lower body with regards to endurance capacity.

6.2.2 Upper Body Strength. Upper body strength was measured through 1RM testing parameters, utilizing consistent protocols standardized by both CSEP and the National Strength and Conditioning Association (NSCA) for cable resisted machines including the lat pull down, biceps curl and triceps extension. For all of the upper body strength testing parameters, there was a significant increase over time for both experimental and control groups and a non-significant difference between the groups. Thus, the hypothesis that an increase in training bar diameter would have a significant effect on upper body strength outcomes when compared to a control group was not supported.
6.3 Implications

In summary, a RT program utilizing the FG training bar attachment had no significant effect on any of the tested parameters when compared to a comparable RT program that did not use an increase in training bar diameter. It is important to note that there were significant differences in baseline activity levels between the experimental and control groups, which may have had an influence on the total extent of physiological adaptations to the RT program. It is well established throughout the literature that trained vs. untrained muscle will experience different adaptations due to both predisposition as well as muscle biology characteristics (Moberg et al., 2020). This may have direct implications on the results of the current study, as the increased baseline physical activity levels reported by the experimental group could have potentially blunted their subsequent adaptations to the program compared to the control group. Even though these activity levels were self-reported, upon reassessment post-intervention, all participants in both groups stated that their level of physical activity remained constant throughout the 6-week RT program. Therefore, it could be argued that with differing activity levels, baseline differences in the biology and adaptability of the participants’ muscles may have had an impact on the results of the current study regarding all testing parameters.

It is also interesting to note differences amongst initial training weights at the beginning of the RT program as stated above. Although there was a non-significant difference between groups, the participants in the experimental group experienced marked increases in grip strength even with select training loads initially set at a lighter training load with respect to what the participant was able to complete without the use of the FG bar attachment. This could hypothetically be due to the increased intensity of the exercise for the individuals, thus leading to
similar increases in grip strength for these participants in comparison to their baseline values. Future investigation is warranted regarding these factors and analysis on differing training loads.

6.4 Limitations

6.4.1 Participant Sample. Conducting research within this age demographic may prove to be particularly difficult when it comes to varying levels of understanding regarding RT techniques potentially due to lack of experience and comfort. As it is vitally important to build trust and rapport at the beginning of any RT program, it is important to note that many of the participants were new to RT in general, increasing the level of importance with form analysis, and explanation of exertion requirements and expectations. With these challenges anticipated at the beginning of the study, utilizing three separate familiarization sessions for each participant was an appropriate way to utilize knowledge translation regarding general expectations and provisions of support for any questions towards the study protocol. However, being able to account for individual participant exertion is challenging to address. Even though initial training loads were determined by referring to the baseline testing results, it is impossible to determine whether or not each participant was truly exerting themself to the level required to obtain an accurate 1RM testing value. With these measurements serving as the benchmark for the beginning of the study, any discrepancies may have had a significant effect on the final testing results.

6.4.2 Health Measures. Although all participants were instructed at the beginning of the study to maintain daily habits (e.g., diet, physical activity) over the course of the program, several measures regarding participant health were not taken into account, including total sleep (e.g., recovery opportunity), nutritional intake (e.g., total protein ingestion), breakdown of self-reported activity levels (e.g., endurance training vs. walking), specific history or participant hobbies (e.g,
past or present participation in sports either competitively or recreationally) and supplement use (e.g. exercise supplement use such as protein powder). Each of these factors may have affected the results regarding changes in participant strength and endurance. Therefore, future research in this area should account for these factors to minimize their effects on future results.

6.4.3 Testing Procedures. Although testing procedures regarding the dependent variables were sufficient in determining muscle strength and endurance characteristics, there was no investigation of muscle size outcomes (i.e. hypertrophy). This lack of testing (e.g. ultrasound, bioelectrical impedance analysis, etc.) makes it challenging to determine whether or not there were indeed any hypertrophy adaptations resulting from the programs. However, as the link between muscle strength and hypertrophy has been commonly cited throughout the literature (Cruz-Jentoft et al., 2018; Hunter et al., 2004), it is important to note that preliminary findings after this 6-week RT protocol are indeed intriguing regarding significant increases in strength over time for both groups.

6.4.4 Resistance Training Program. Aging muscle may respond differently to RT programs regarding both strength and endurance (Hunter et al., 2004). Additionally, the time frame of the current study being 6 weeks, with only 2 training sessions per week, is considered to be a low volume regarding a RT program in comparison to some more extensive RT protocols reported in the literature (Conlon et al., 2017). However, the results shown in the short amount of time used in the current study are nonetheless intriguing, and therefore warrant future research, specifically with the potential of a decreased volume eliciting optimal results regarding muscle strength and endurance.

6.4.5 COVID-19 Global Pandemic. Due to the global COVID-19 pandemic, specific safety precautions were put in place on an institutional level forcing the difficult decision to suspend
the study before the number of required participants determined by the a priori sample size estimate was recruited. This reduced the power of the study and therefore may have impacted the results.

6.4.6 Previous Research. To the authors knowledge, this is the first study aiming to address research questions surrounding the effect of using an increase in training bar diameter within an aging demographic. Serving as a benchmark study is challenging as there is no previous information to inform study design and protocols, specifically regarding participant demographics and testing parameters.

6.5 Conclusions and Future Research

It is well documented that the maintenance of muscular strength and endurance is of vital importance as one progresses through the aging process, specifically those susceptible to the increased risk of developing adverse symptoms of both sarcopenia (i.e. loss of muscle mass) and dynapenia (i.e. loss of muscle strength) after the fifth decade of life (Cruz-Jentoft et al., 2018). Currently, little research has investigated the physiological effects of specific training interventions to counteract these musculoskeletal deficiencies specifically regarding grip strength, grip endurance, and upper body strength within older adults.

The current study demonstrated that a 6-week RT program utilizing the FG training bar attachment was not associated with significant differences regarding changes in total grip strength, grip endurance or upper body strength when compared to a similar RT program not utilizing the FG attachment. However, due to several potential limitations of the study regarding participant demographics (i.e. baseline activity level) and measurement factors (e.g. health cofactors such as nutrition and sleep), future studies within this area of research are warranted regarding more strict parameters of participant selection and surveillance. Future research should
also investigate the potential effect of decreased training weight on study findings. As it becomes more vital to elicit specific training interventions to allow for greater levels of independence and quality of life, this is an important area of research to expand for the health of individuals within this age demographic.
References


Rogers, H. C. (2016). Effects of Fat GripzTM Training by Female University Students, Faculty and Staff Members on Hand Grip Strength and Maximal Deadlift (Doctoral dissertation, Drexel University).


Appendix A: REB Certificate of Approval

<table>
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<tr>
<th>PRINCIPAL INVESTIGATOR</th>
<th>DEPARTMENT</th>
<th>REB#</th>
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<tr>
<td>Michael Markewich</td>
<td>Faculty of Kinesiology and Health Studies</td>
<td>2019-101</td>
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SUPERVISOR: Dr. Paul Bruno

TITLE
Effects of Training with an Increase in Training Bar Diameter on Strength and Functional Endurance Within Older Adults

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<th>APPROVED ON</th>
<th>RENEWAL DATE</th>
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<tr>
<td>July 16, 2019</td>
<td>July 16, 2020</td>
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APPROVAL OF
Application for Behavioural Research Ethics Review
Recruitment Email
Intake Form
Consent Form
Recruitment Poster
Study Information Sheet
Get Active Questionnaire
Master List

Full Board Meeting

Delegated Review

The University of Regina Research Ethics Board has reviewed the above-named research project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this research project, and for ensuring that the authorized research is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol, or related documents.

Any significant changes to your proposed method, procedures or related documents should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS
In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month of the current expiry date each year the study remains open, and upon study completion. Please refer to the following website for the renewal and closure forms:
https://www.uregina.ca/research/for-faculty-staff/ethics-compliance/human/ethicsforms.html

Chris Street PhD
REB Chair
University of Regina

Please send all correspondence to:
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Appendix B: Study Information Sheet

STUDY INFORMATION SHEET

Project Title: Effects of Training With an Increase in Training Bar Diameter on Strength and Functional Endurance In Older Adults

Researchers: Michael Markewich BKin, CSEP-CEP; Paul Bruno DC, PhD

Introduction to the study
You are being asked to take part in a research study investigating and comparing the effects of two resistance training programs on strength and functional endurance outcomes in adults aged ≥50 years. Before you decide whether or not to take part, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully and ask questions of the researchers if there is anything that is not clear or if you would like more information.

What does participation in the study entail?
Your participation will involve the completion of: 1) three familiarization sessions (~60 minutes), which will include a baseline testing session; 2) a resistance-training program consisting of 12 training sessions (~30 minutes) over a six-week period (2 sessions/week); and 3) a post-intervention testing session. All training and testing sessions will be supervised by a CSEP Certified Exercise Physiologist, which is currently the most respected certification in Canada regarding exercise science.

Familiarization Sessions
Session #1: You will be introduced to the study and have the opportunity to ask questions before being asked to complete the following forms: Intake Form, Get Active Questionnaire, Informed Consent Form.

Session #2: You will undergo baseline testing, which will include the following protocols:

i) **Handgrip Strength**: Maximal handgrip strength will be assessed using a Jamar Handgrip Dynamometer according to the testing protocol prescribed by CSEP. This involves two measurements in total kilograms taken from each hand (i.e., 4 trials in total), where the two maximal scores (maximum from each hand) are added together to create a total measure of handgrip strength.

ii) **Handgrip Endurance**: Handgrip endurance will be assessed using a double kettlebell hold and farmer’s carry. The double kettlebell hold involves holding a kettlebell (30% of your bodyweight) in each hand for as long as possible. The farmer’s carry involves walking as far as possible while holding a kettlebell (20% of your bodyweight) in each hand.

iii) **Upper Body Strength**: Upper body strength will be assessed using a one-repetition maximum test for the cable-resisted pull down, bicep curl, and triceps extension exercises. All three exercises will follow the same testing protocol, which will be comprised of the following: (1) standard dynamic warm-up lasting 5 minutes, (2) 1 set of 10 repetitions using a weight determined to be comfortable and relatively easy followed by 1 set of 5 repetitions using an increased weight (e.g., 20% higher), (3) two minutes following the warm-up sets, weight will be progressively increased for each subsequent attempt with a 5-minute rest interval in between attempts until a one-repetition maximum is achieved.

Session #3: You will be introduced to the exercises that will be completed in the training program. The session will cover explanation and demonstration of proper form for each exercise, as well as an explanation surrounding the program that consists of various exercises related to the programming goals of increasing handgrip strength, handgrip endurance, and upper body strength. At this time, explanation of concepts surrounding effective breathing technique and rest times will be addressed. Additional testing will be done to determine the starting weight for the single-arm dumbbell row and farmer’s carry exercises that will be used in the training program.

i) **Single Arm Dumbbell Row**: The starting weight will be determined using an 8-rep maximum test for the single arm dumbbell row to ensure an appropriate starting exercise intensity.

ii) **Farmer’s Carry**: The starting weight will be determined by finding a weight that can be carried for 20 metres while eliciting a relative perceived exertion score of 8-10 (out of 10) to ensure an appropriate starting exercise intensity.
Training Sessions

Each training session will consist of the following:

i) 5 minute warm-up period (various dynamic stretching).

ii) Farmers carry with dumbbells (3sets x 20 metre track).

iii) Single arm dumbbell row (3sets x 6-8repetitions/arm).

iv) Cable resisted pull down (hands positioned shoulder width apart, pronated grip; 3sets x 6-8repetitions/arm).

v) Cable resisted bilateral bicep curl (supinated grip; 3sets x 6-8repetitions/arm).

vi) Cable resisted bilateral triceps extension (neutral grip; 3sets x 6-8repetitions/arm).

vii) 5 minute cool-down session (various static stretching)

Post-Intervention Testing Session

You will undergo the same testing protocols that were used in the second familiarization session (see above).

Do I have to participate?

Participation in this project is completely voluntary, and there is no penalty for deciding not to participate. If you do decide to participate, you may keep this information sheet and will be asked to sign a consent form and Get Active Questionnaire. Also, if you do decide to participate, you are free to withdraw at any time and without giving a reason. You may also withdraw from the study at any point prior to the dissemination of the study findings (e.g., publications, presentations), which is estimated to begin in January 2020, by contacting the researchers (contact information below).

What are the benefits of participating in this study?

The results of this research study will provide clinicians, physicians and academic professionals with evidence regarding the use of specific training modalities to potentially have a positive effect on musculoskeletal health involving the upper limbs (e.g., strength, endurance, functionality). It is hypothesised that both training groups will experience positive adaptations to the resistance training program, with the potential to increase both muscular strength and endurance capacity, which in turn has been shown to promote positive effects on overall quality of life and independence.

What are the risks of participating in this study?

You will be engaging in high-intensity resistance exercise during the testing and training sessions. You may experience temporary fatigue during or immediately following exercise, and possible muscle soreness 24-72 hours afterward. There is also a risk of musculoskeletal injury while performing the exercise (e.g., strains, sprains), and a very small chance of more serious injury (e.g., fracture, tendon rupture)

Is confidentiality regarding personal information ensured?

All information collected during the course of this research study will be kept completely confidential. Your signed informed consent and other paper forms will be stored in a locked filing cabinet in a Faculty office. Electronic data files will be stored on a password-protected computer in the Aging Muscle and Bone Health Laboratory. The only individuals who will have access to these forms and files are the researchers involved in this study. Any published information based on the data collected in this study will not have your name or other identifying markers appended to it.

What will happen to the results of this study?

The results of this study will be submitted as part of the principal investigator’s Master’s Thesis, and may be published in academic journals and presented at academic conferences.

Who has reviewed this study?

The ethics for this study have been reviewed and approved by the Research Ethics Boards of the University of Regina.

Contact Information

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Appendix C: Informed Consent Form

Project Title: Effects of Training With an Increase in Training Bar Diameter on Strength and Functional Endurance In Older Adults

Researchers: (PI) Michael Markewich BKin, CSEP-CEP  
(Supervisor) Paul Bruno DC, PhD

i. I confirm that I have read and understand the Study Information Sheet for this research project and have had the opportunity to ask questions regarding any concerns.

ii. I understand that my participation in this study is voluntary and that I am able to withdraw at any time free from repercussions prior to the dissemination of study findings by informing the principal investigator (PI).

iii. I acknowledge that I will be engaging in high intensity resistance training exercise. I understand that I may experience temporary fatigue during or immediately following the exercise, and that potential muscle soreness 24-72 hours following a given training session may occur.

iv. I acknowledge that I have received a copy of the Informed Consent Form, Study Information Sheet, and have signed and dated the Get Active Questionnaire.

v. I understand the risks associated with this research project described on the Study Information Sheet. I have had the opportunity to ask questions regarding what my participation in the research study entails, and I am willing to continue as a participant within the research study.

________________________  ______________________
Participant Name (please print)      Date             Signature

________________________  ______________________
Principal Investigator                 Date            Signature

Contact Information:

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<tr>
<th>Principal Investigator</th>
<th>Research Supervisor</th>
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<tr>
<td>Michael Markewich BKin, CSEP-CEP</td>
<td>Paul Bruno DC, PhD</td>
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<td>Faculty of Kinesiology and Health Studies</td>
<td>Faculty of Kinesiology and Health Studies</td>
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<td>Email Address: <a href="mailto:paul.bruno@uregina.ca">paul.bruno@uregina.ca</a></td>
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<tr>
<td>Phone number: (306) 550-1224</td>
<td>Phone Number: (306) 337-3343</td>
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This research project was reviewed and approved on ethical grounds by the Research Ethics Board of the University of Regina. Any questions regarding your rights as a participant may be addressed to that committee through the U of R Research Ethics Office at research.ethics@uregina.ca or (306) 585-4775.